QD-QA-024
REVISION G
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ORGANIZATIONAL INSTRUCTION

ULTRASONIC INSPECTION

OPR(s)	**OPR DESIGNEE**
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DOCUMENT HISTORY LOG

Status (Baseline/ Revision/ Canceled)	Document Revision	Effective Date	Description
Baseline		11/21/97	Initial release.
Revision	A	01/29/99	Added two applicable documents. In section 4.1.1 added guidance on use of calibration blocks. In section 4.1.2 added guidance on checking test system performance. In section 4.1.3 added requirement for Certificates of Compliance.
Revision	B	05/15/99	Add MSFC-STD-1249 and MIL-STD-2154 to paragraph 5.1, Reference Documents.
Revision	C	7/1/99	Changes made to reflect new organization code changes and/or Changes made to reflect new directives renumbering scheme and to incorporate the corrective action for closure of NCR 266.
Administrative	N/A	8/30/00	OPR and/or OPR Designee change due to personnel transfer or other administrative reason. No other change to this document has been made.
Revision	D	9/09/02	Format and numbering change to implement requirements of QS-A-001 rev F.
Revision	E	05/05/03	Changes made to reflect new organization. Revised wording in section 1.2. Revised document reference in Applicable Documents. In section 4.1.1 deleted “with flat-bottom holes”. Revised section 4.7.1 for wrought aluminum and steel. Added two reference documents to section 5.1. Revised section 9.a and 9.b.
Revision	F	10/1/04	Revised to bring document in compliance with the HQ Rules Review Action (CAITS: 04-DA01-0387). Changes were also made to reflect S&MA organizational name changes (i.e., QS to QD).
Revision	G	11/22/05	Administrative Revision changed OPR

ULTRASONIC INSPECTION

1. SCOPE

1.1 Scope. This instruction applies to ultrasonic inspection and ultrasonic test (UT) witnessing performed on in-scope flight hardware that contains steel and aluminum plate, steel and aluminum welds and heat-affected zones, using the contact method, by MSFC Safety and Mission Assurance Office (S&MA) personnel, support contractors or the NASA/MSFC NDE Team .

1.2 Purpose. This instruction provides requirements for ultrasonic inspection and UT witnessing to ensure a consistent manner that will provide reliable results and to comply with MPG 8730.1.

1.3 Applicability. This instruction is applicable to NASA/MSFC and support contactor personnel that perform ultrasonic inspection or UT witnessing on in-scope flight hardware.

2. APPLICABLE DOCUMENTS

ASTM-E127	Standard Practice for Fabricating and Checking Aluminum-Alloy Ultrasonic Standard Reference Blocks
ASTM-E428	Standard Practice for Fabrication and Control of Steel Reference Blocks Used in Ultrasonic Inspection
MPR 8730.1	Inspection and Testing
MWI 3410.1	Personnel Certification Program
MIL-STD-2154	Ultrasonic Inspection Process for Wrought Metals

3. DEFINITIONS

a. A-Scan. A method of data presentation on a CRT (cathode ray tube) screen utilizing a horizontal base line that indicates distance or time, and a vertical deflection from the base line that indicates amplitude.

b. Amplitude**.** The vertical pulse height of a signal, usually base to peak, when indicated by an A-scan presentation.

c. Angle Beam**.** A wave train traveling at an angle measured from the normal to the test surface to the centerline of the beam.

d. Attenuation**.** The loss of sound energy as the ultrasonic vibrations travel through the medium.

e. Back Reflection**.** Indication on the CRT of the echo from the far boundary of the materials under test.

f. C-Scan**.** A means of data presentation that provides a plan view of the material and discontinuities.

g. DAC**.** Distance amplitude correction - electronic change of amplification.

h. Ghost Indication**.** Usually non-reproducible indications caused by superfluous energy reflected back to the search unit.

i. Pulse Echo Method**.** An inspection method in which the presence and position of a reflector are indicated by the echo amplitude and time.

j. Reflector**.** An interface at which an ultrasonic beam encounters a change in characteristic impedance and reflects.

k. Signal-to Noise Ratio**.** The ratio of the amplitude of an ultrasonic indication to the amplitude of the maximum background noise.

l. Straight Beam**.** A vibrating pulse wave train traveling normal to the test surface.

4. INSTRUCTIONS

4.1 General.

4.1.1 Standard Calibration blocks are required to calibrate the system. The standards shall be in accordance with ASTM-E127 and ASTM-E428.

4.1.2 In order to check test system performance characteristics, standardization of systems with respect to sensitivity shall be performed prior to and immediately after each inspection and after any changes in instrument settings, or instrument modules, and at two hour intervals during continuous operation.

4.1.3 All reference standards shall conform to the appropriate dimensional and surface finish requirements, and shall be of the same material as the material being inspected. Procured reference standards shall have Certificates of Compliance (COC) per ASTM-E127 and ASTM-E428.

4.2 Procedure.

4.2.1 Couplant shall be appropriate for the part and must maintain good ultrasonic energy transmission into the part.

4.2.2 The surface shall be free from loose, heavy scale, machining or grinding particles, and other contaminates.

4.2.3 Visually inspect the part prior to ultrasonic inspection for cracks, nicks, gouges, raised areas, irregular machining and tool tears. Contact appropriate personnel for surface defect removal.

4.2.4 When inadequate sound transmission is experienced, the test surface or reflection surface shall be considered suspect until determined otherwise.

4.3 Standardization and testing shall be performed by the ultrasonic frequency that provides the penetration and resolution required for the production material. Check test system performance characteristics prior to use by running distance amplitude curves for each transducer and test equipment combination as applies to the part or material being inspected.

4.4 The scanning speed shall not exceed the maximum scanning speed that provides for detection of all discontinuities in the reference standards used to set up the test.

4.5 When possible, initial scanning shall be parallel to the major grain flow. Angular manipulation shall be used to obtain maximum response from individual discontinuities. In addition, when referencing specifications indicates directions of maximum stressing or engineering drawings, scanning shall be performed to locate discontinuities that are oriented in specified directions.

4.5.1 When entry surface resolution (based on 2 to 1 or greater signal-to-noise ratio) is not sufficient to resolve discontinuities near the test surface, additional tests shall be performed from the opposite side.

4.5.2 For each inspection direction, tests from opposite sides are required when the maximum metal travel distance is such that the minimum size discontinuity of the applicable class cannot be detected by tests applied from only one side.

4.6 Clean parts to remove couplant as appropriate.

4.7 Acceptance.

4.7.1 Ultrasonic classes governing the acceptance of parts and material will be determined by drawings, specifications and work authorizing documents. Classes for wrought aluminum and steel are listed in MIL-STD-2154, table VI.

4.7.2 Personnel performing UT shall be certified to Level I. Personnel performing evaluation of the test shall be certified to at least Level II.

4.7.3 When required by customer requirements, complete Appendix A. If parts or materials are rejected, generate appropriate nonconformance documentation. Notify appropriate engineering or contractor personnel for disposition.

5. NOTES

5.1 Reference Documents. The following reference documents provide additional information concerning the subject of Ultrasonic Inspection:

MSFC-STD-1249	Standard NDE Guidelines and Requirements for Fracture Control Programs
MIL-STD-2154	Ultrasonic Inspection Process for Wrought Metals
ASTM B594-97	Standard Practice for Ultrasonic Inspection of Aluminum Alloy Wrought Products for Aerospace Application
ASTM E164-97	Standard Practice for Ultrasonic Contact Examination of Weldments

The Project Office shall specify in the Project Quality Plan the organization and the minimum period of time for maintaining the ultrasonic inspection records that are to be stored.

6. SAFETY PRECAUTIONS AND WARNING NOTES

None.

7. APPENDICES, DATA, REPORTS, AND FORMS

Appendix A Record of Ultrasonic Inspection

8. RECORDS

None

9. TOOLS, EQUIPMENT, AND MATERIALS

a. Pulse Echo ultrasonic equipment generating frequencies to read frequencies as a minimum over a range of 2.25 MHZ to 10 MHZ.

b. Transducers with frequencies to read frequencies as a minimum over a range of 2.25 MHZ to 10 MHZ.

c. Couplant material: water, grease, oil, penetrant emulsifier, water soluble gels; couplant must be compatible with the material being tested

d. Standard Reference Blocks

10. PERSONNEL TRAINING AND CERTIFICATION

Personnel that perform ultrasonic testing or UT witnessing for hardware acceptance will be certified in accordance with MWI 3410.1.

11. FLOW DIAGRAM

None.

Appendix A

RECORD OF ULTRASONIC INSPECTION

TPS/WORK. AUTH.#_____ PROG./PROJ._____
INSP. DATE_____ INSP. PROC. #/REV. _____ ACCEP. SPEC. #/REV_____ DWG. # _____
PART NAME/DESCRIPTION _____ MATERIAL TYPE_____ CLASS # _____ WELD LENGTH _____ JOINT DESIGN _____ MATERIAL THICKNESS_____

TECHNIQUE (circle one) CONTACT IMMERSION WATER COLUMN

EQUIPMENT_____ MODEL _____ S/N _____

TRANSDUCER MFG._____ P/N_____ S/N _____

FREQ._____ SIZE _____ ANGLE _____

WEDGE MATERIAL_____ THICKNESS _____
COUPLANT_____ WATER PATH DIST. _____

CAL. PROC._____ CAL. BLOCK S/N _____
CAL. BLOCK HOLE SIZE_____ CAL BLOCK MAT'L. _____

DAC. PTS._____ DAC. AMPL._____ REJ. AMPL. _____

INSTRUMENT SETTINGS:
DELAY: COARSE_____ FINE_____
RANGE: COARSE_____ FINE_____
FILTER: _____ **DAMPING**:_____
GAIN: _____ **+6 db** _____
GATE: (circle) OFF ON **# OF GATES**_____ GATE AMPL. _____
SCAN INDEX SIZE _____

INDICATIONS FOUND: _____
SEE ATTACHED SKETCH OF INDICATIONS

ACCEPT REJECT

INSPECTOR_____ LEVEL_____ EMPLOYER_____

INSPECTOR_____ LEVEL_____ EMPLOYER_____